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Lime Kiln Dust as a Potential Raw Material in Portland Cement Manufacturing

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In the United States, the manufacture of portland cement involves burning in a rotary kiln a finely ground proportional mix of raw materials. A rotary kiln is a long cylindrical kiln with a refractory lining, inclined at a slight angle, rotating at a slow speed, and fired by fuel at the lower end. The raw material mix provides the required chemical combination of calcium, silicon, aluminum, iron, and small amounts of other ingredients. The majority of calcium is supplied in the form of calcium carbonate (commonly limestone, although other calcareous materials such as chalk or marl may be used). Two different processes “dry” and “wet” are used in the manufacture of portland cement. In the dry process, a mixture of raw materials are ground, mixed, and fed into the kiln in a dry state. In the wet process, the mixture of raw materials are ground with water, thoroughly mixed, and then fed into the kiln in the form of a slurry. In other respects, the two processes are essentially alike. The raw materials are heated to a sintering temperature of between 1,400° C and 1,500° C causing a series of chemical reactions that forms portland cement clinker (Johnson, 1985; Portland Cement Association, undated).

The design of the raw material mix takes into account only the chemical oxide composition of the ingredients and basically ignores their mineralogical or physical form. Therefore, rocks such as limestone are usually selected as the principal source of calcium (or lime, CaO) simply because of their widespread availability. Other sources including waste materials or byproducts from other industries can be used to supply CaO, provided they have sufficiently high CaO content, have low magnesia (MgO) content (less than 5 percent), and are competitive with limestone in terms of cost and adequacy of supply (Mishulovich, 2003).

The production of high-calcium lime utilizes essentially the same calcination process, but involves only the burning of limestone (although at a lower temperature of between 1,000° C and 1,350° C). The most common lime kiln design used in the United States is the rotary kiln, with or without a preheater. Preparation of lime kiln feed involves mining or quarrying the limestone and crushing to a graded size that is usually between 9.5 millimeters (mm) (0.375 inches) and 6.3 centimeters (2.5 inches) in diameter.

During the stone’s trip through the kiln, significant amounts of lime kiln dust (LKD) are generated, which is collected by dust control systems. Different types of dust control equipment are used, but basically the systems can be classified as either wet or dry. The chemical composition of LKD from high-calcium lime plants varies widely depending on factors such as the physical and chemical characteristics of the limestone used, the type of kiln used, whether a preheater is used, operating parameters of the kiln, reactivity of the lime produced, and analysis of the fuel used. The LKD material may contain roughly equal amounts of free/available CaO and uncalcined calcium carbonate, and lesser amounts of impurities such as MgO derived from the limestone. Just as the chemical analysis shows great variability, a physical analysis displays a particle size gradation that may range from 0.005 mm to 2.0 mm. The bulk of the material will be very fine; typically 75% of the LKD is 0.03 mm or smaller.

It is estimated that about 2.5 million metric tons of high-calcium LKD is produced annually in the United States. There are a number of established uses for LKD, but nationally supply has always exceeded demand by a wide margin. Regardless of the use, LKD has a low unit value and the distance to its potential consumption site is the controlling factor in its use. Since other competing materials are usually available, transportation costs become prohibitive if the distance between the lime plant and the use site are too great. In general, the chemical and physical characteristics of most high-calcium LKDs make these materials suitable for use as a supplemental source of CaO in the cement raw material mix. The potential use of LKD by an individual cement plant will depend on the chemistry of the LKD, adequacy of supply, and cost of the LKD. As a result, a map and table were developed showing the location of cement plants and high-calcium lime plants in the conterminous United States. The circles shown on the map (figure 1) show areas where cement and lime plants are within 25 linear miles of each other. These areas are identified on the map by letter codes, which are listed alphabetically in table 1 so that plants can be located by region and the specific distance relationships examined. In some cases, multiple operations are located within a particular circle and more than one cement plant may be associated with each lime plant, alternatively, more than one lime plant may be associated with each cement plant. Table 2 lists the cement-lime plant pairs sorted by distance, from closest to farthest, up to 50 linear miles. Each table also indicates whether the cement is operating a dry or wet process and whether the lime plant is operating a dry or wet LKD recovery process.

References

- Johnson, Wilton, 1985, Cement, *in* Mineral Facts and Problems 1985: U.S. Bureau of Mines Bulletin 675, p. 121-131.
- Mishulovich, Alex, 2003, Alternative materials: International Cement Review, January, p. 59-62.
- Portland Cement Association, [undated], History & manufacture of portland cement, web site at http://www.cement.org/basics/concretebasics_history.asp. Accessed July 28, 2004.

Figure 1
Cement Plants in the Conterminous United States that are Within 25 Miles of a High-Calcium Lime Plant

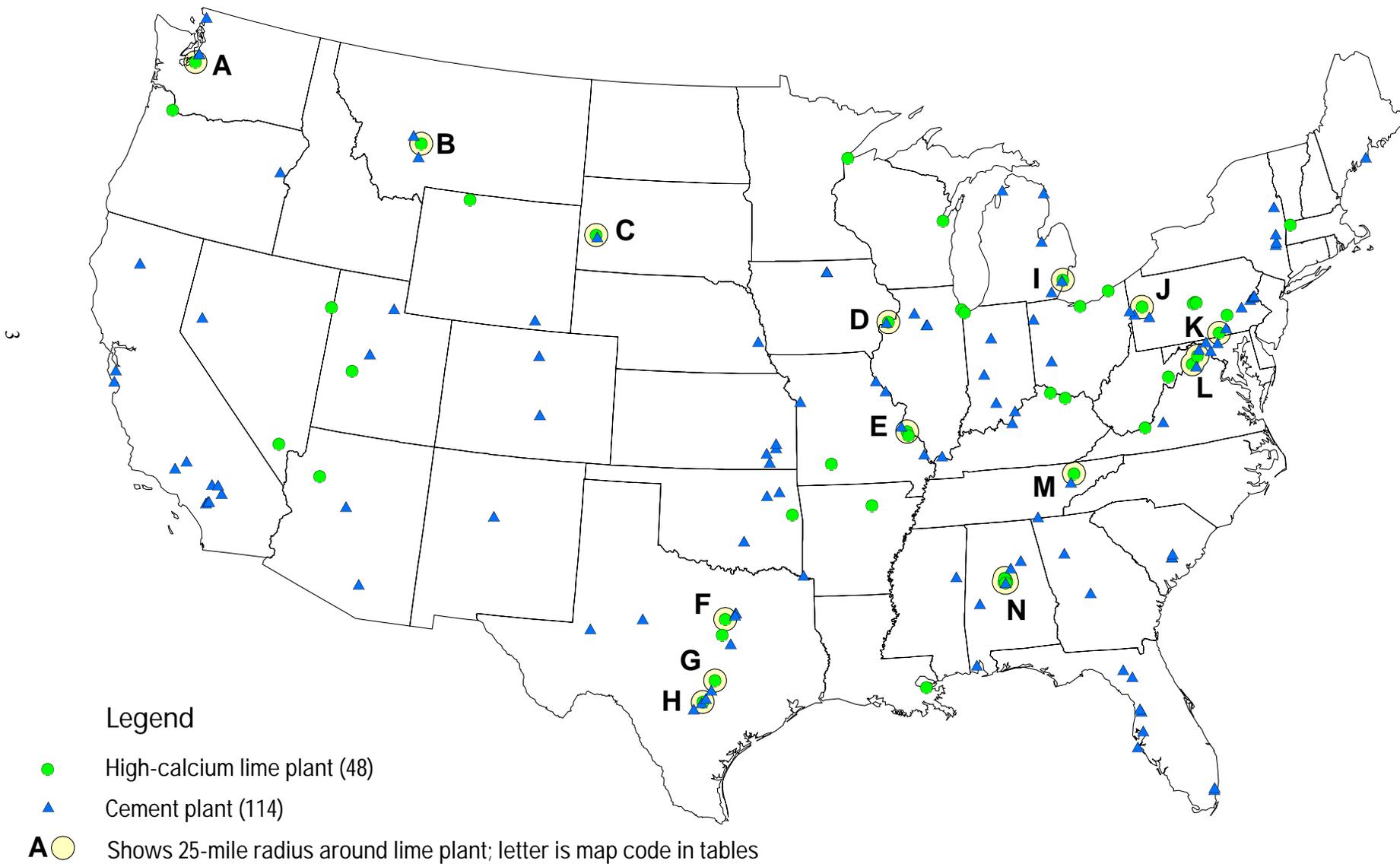


TABLE 1
CEMENT AND LIME PLANT PAIRS SORTED BY MAP CODE

Map Code	Linear Distance (miles)	Commodity	Company	Site	State	County	Cement Kiln Type*	Lime Kiln Dust Control Type*	
A	19	CEMENT LIME	LAFARGE NORTH AMERICA INC GRAYMONT WESTERN US INC	SEATTLE PLANT TACOMA LIME PLANT	WASHINGTON WASHINGTON	KING PIERCE	Wet	Dry	
A	20	CEMENT LIME	ASH GROVE CEMENT CO GRAYMONT WESTERN US INC	SEATTLE PLANT TACOMA LIME PLANT	WASHINGTON WASHINGTON	KING PIERCE	Dry	Dry	
B	25	CEMENT LIME	ASH GROVE CEMENT CO GRAYMONT WESTERN US INC	MONTANA CITY PLANT INDIAN CREEK LIME PLANT	MONTANA MONTANA	JEFFERSON BROADWATER	Wet	Dry	
B	29	CEMENT LIME	HOLCIM (US) INC GRAYMONT WESTERN US INC	TRIDENT PLANT INDIAN CREEK LIME PLANT	MONTANA MONTANA	GALLATIN BROADWATER	Wet	Dry	
C	4	CEMENT LIME	GCC DACOTAH INC PETE LIEN & SONS INC	RAPID CITY PLANT RAPID CITY LIME PLANT	SOUTH DAKOTA SOUTH DAKOTA	PENNINGTON PENNINGTON	Dry and Wet	Dry	
D	4	CEMENT LIME	LAFARGE CORPORATION LINWOOD MINING & MINERALS CORP	DAVENPORT PLANT LINWOOD LIME PLANT	IOWA IOWA	SCOTT SCOTT	Dry	Dry	
E	18	CEMENT LIME	BUZZI UNICEM USA INC CHEMICAL LIME CO	SELMA PLANT STE GENEVIEVE PLANT	MISSOURI MISSOURI	JEFFERSON STE GENEVIEVE	Dry	Dry	
E	26	CEMENT LIME	BUZZI UNICEM USA INC MISSISSIPPI LIME CO	SELMA PLANT STE GENEVIEVE LIME PLANT	MISSOURI MISSOURI	JEFFERSON STE GENEVIEVE	Dry	Dry and Wet	
4	F	23	CEMENT LIME	TXI CORP US LIME & MINERALS - TEXAS LIME CO	MIDLOTHIAN PLANT CLEBURNE LIME PLANT	TEXAS TEXAS	ELLIS JOHNSON	Dry and Wet	Dry and Wet
F	26	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHEMICAL LIME CO	WACO PLANT CLIFTON LIME PLANT	TEXAS TEXAS	MCLENNAN BOSQUE	Wet	Wet	
F	26	CEMENT LIME	ASH GROVE TEXAS CEMENT US LIME & MINERALS - TEXAS LIME CO	MIDLOTHIAN PLANT CLEBURNE LIME PLANT	TEXAS TEXAS	ELLIS JOHNSON	Wet	Dry and Wet	
F	27	CEMENT LIME	HOLCIM (US) INC US LIME & MINERALS - TEXAS LIME CO	MIDLOTHIAN PLANT CLEBURNE LIME PLANT	TEXAS TEXAS	ELLIS JOHNSON	Dry	Dry and Wet	
G	22	CEMENT LIME	TEXAS - LEHIGH CEMENT CO AUSTIN WHITE LIME CO	BUDA PLANT MCNEIL LIME PLANT	TEXAS TEXAS	HAYS TRAVIS	Dry	Dry and Wet	
H	2	CEMENT LIME	CEMEX USA CHEMICAL LIME CO	BALCONES PLANT NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	COMAL COMAL	Dry	Dry	
H	10	CEMENT LIME	TXI CORP CHEMICAL LIME CO	HUNTER PLANT NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	COMAL COMAL	Dry	Dry	
H	15	CEMENT LIME	ALAMO CEMENT CO CHEMICAL LIME CO	PLANT 1604 (SAN ANTONIO) NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	BEXAR COMAL	Dry	Dry	
H	24	CEMENT LIME	CAPITOL AGGREGATES LTD CHEMICAL LIME CO	CAPITOL CEMENT (SAN ANTONIO) PLANT NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	BEXAR COMAL	Dry and Wet	Dry	

* Cement kilns use raw materials that are either a mixture of "dry" materials or a slurry of "wet" materials. The lime kiln dust (LKD) control processes used at lime kilns consist mainly of systems using fabric filters, electrostatic precipitators, or scrubbers. Fabric filters (baghouses) and electrostatic precipitators produce "dry" LKD, which would be a suitable raw material in "dry" process cement kilns. Scrubbers produce "wet" LKD, which would be a suitable raw material in "wet" process cement kilns.

TABLE 1 (CONTINUED)
CEMENT AND LIME PLANT PAIRS SORTED BY MAP CODE

Map Code	Linear Distance (miles)	Commodity	Company	Site	State	County	Cement Kiln Type	Lime Kiln Dust Control Type
H	32	CEMENT LIME	TEXAS - LEHIGH CEMENT CO CHEMICAL LIME CO	BUDA PLANT NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	HAYS COMAL	Dry	Dry
I	2	CEMENT LIME	ST MARY'S CEMENT CARMEUSE LIME	DETROIT PLANT RIVER ROUGE LIME PLANT	MICHIGAN MICHIGAN	WAYNE WAYNE	Dry	Dry
I	36	CEMENT LIME	HOLCIM (US) INC CARMEUSE LIME	DUNDEE PLANT RIVER ROUGE LIME PLANT	MICHIGAN MICHIGAN	MONROE WAYNE	Wet	Dry
J	22	CEMENT LIME	CEMEX USA MERCER LIME & STONE CO	WAMPUM PLANT BRANCHTON LIME PLANT	PENNSYLVANIA PENNSYLVANIA	LAWRENCE BUTLER	Dry	Wet
J	27	CEMENT LIME	ARMSTRONG CEMENT & SUPPLY CORP MERCER LIME & STONE CO	CABOT PLANT BRANCHTON LIME PLANT	PENNSYLVANIA PENNSYLVANIA	BUTLER BUTLER	Wet	Wet
J	28	CEMENT LIME	ESSROC MATERIALS INC MERCER LIME & STONE CO	BESSEMER PLANT BRANCHTON LIME PLANT	PENNSYLVANIA PENNSYLVANIA	LAWRENCE BUTLER	Wet	Wet
K	19	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CARMEUSE LIME	YORK WHITE CEMENT PLANT HANOVER LIME PLANT	PENNSYLVANIA PENNSYLVANIA	YORK ADAMS	Wet	Wet
K	21	CEMENT LIME	LEHIGH CEMENT CO CARMEUSE LIME	UNION BRIDGE PLANT HANOVER LIME PLANT	MARYLAND PENNSYLVANIA	CARROLL ADAMS	Dry	Wet
S K	27	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CARMEUSE LIME	YORK WHITE CEMENT PLANT MILLARD LIME PLANT	PENNSYLVANIA PENNSYLVANIA	YORK LEBANON	Wet	Dry
K	34	CEMENT LIME	ST LAWRENCE CEMENT CO (HOLCIM, LTD) CARMEUSE LIME	HAGERSTOWN PLANT HANOVER LIME PLANT	MARYLAND PENNSYLVANIA	WASHINGTON ADAMS	Dry	Wet
K	36	CEMENT LIME	LEHIGH CEMENT CO CARMEUSE LIME	EVANSVILLE PLANT MILLARD LIME PLANT	PENNSYLVANIA PENNSYLVANIA	BERKS LEBANON	Dry	Dry
L	10	CEMENT LIME	RIVERTON CORP (ESSROC CEMENT CORP) GLOBAL STONE CHEMSTONE INC	RIVERTON PLANT STRASBURG LIME PLANT	VIRGINIA VIRGINIA	WARREN SHENANDOAH	Dry	Dry and Wet
L	15	CEMENT LIME	CAPITOL CEMENT CORP (ESSROC CEMENT CORP) GLOBAL STONE CHEMSTONE INC	MARTINSBURG PLANT WINCHESTER LIME PLANT	WEST VIRGINIA VIRGINIA	BERKLEY FREDERICK	Wet (likely to be converted to dry within the next 5 years)	Dry
L	22	CEMENT LIME	RIVERTON CORP (ESSROC CEMENT CORP) GLOBAL STONE CHEMSTONE INC	RIVERTON PLANT WINCHESTER LIME PLANT	VIRGINIA VIRGINIA	WARREN FREDERICK	Dry	Dry
L	31	CEMENT LIME	ESSROC MATERIALS INC GLOBAL STONE CHEMSTONE INC	FREDERICK PLANT WINCHESTER LIME PLANT	MARYLAND VIRGINIA	FREDERICK FREDERICK	Wet	Dry
L	35	CEMENT LIME	CAPITOL CEMENT CORP (ESSROC CEMENT CORP) GLOBAL STONE CHEMSTONE INC	MARTINSBURG PLANT STRASBURG LIME PLANT	WEST VIRGINIA VIRGINIA	BERKLEY SHENANDOAH	Wet (likely to be converted to dry within the next 5 years)	Dry and Wet
L	36	CEMENT LIME	ST LAWRENCE CEMENT CO (HOLCIM, LTD) GLOBAL STONE CHEMSTONE INC	HAGERSTOWN PLANT WINCHESTER LIME PLANT	MARYLAND VIRGINIA	WASHINGTON FREDERICK	Dry	Dry
M	20	CEMENT LIME	CEMEX USA GLOBAL STONE TENN LUTTRELL INC	KNOXVILLE PLANT LUTTRELL LIME PLANT	TENNESSEE TENNESSEE	KNOX UNION	Dry	Dry

TABLE 1 (CONTINUED)
CEMENT AND LIME PLANT PAIRS SORTED BY MAP CODE

Map Code	Linear Distance (miles)	Commodity	Company	Site	State	County	Cement Kiln Type	Lime Kiln Dust Control Type	
9	N	3	CEMENT LIME	LAFARGE NORTH AMERICA INC CHEMICAL LIME CO	ROBERTA PLANT O'NEAL LIME PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry
	N	0	CEMENT LIME	LAFARGE NORTH AMERICA INC SOUTHERN LIME CO	ROBERTA PLANT ROBERTA LIME PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry
	N	5	CEMENT LIME	LAFARGE NORTH AMERICA INC CHEMICAL LIME CO	ROBERTA PLANT MONTEVALLO PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry and Wet
	N	8	CEMENT LIME	LAFARGE NORTH AMERICA INC CARMEUSE LIME	ROBERTA PLANT LONGVIEW LIME PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry and Wet
	N	9	CEMENT LIME	LAFARGE NORTH AMERICA INC CHENEY LIME & CEMENT CO	ROBERTA PLANT LANDMARK LIME PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry
	N	10	CEMENT LIME	LAFARGE NORTH AMERICA INC CHEMICAL LIME CO	ROBERTA PLANT ALABASTER PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Wet
	N	26	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHEMICAL LIME CO	LEEDS PLANT ALABASTER PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Wet
	N	27	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHENEY LIME & CEMENT CO	LEEDS PLANT LANDMARK LIME PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry
	N	27	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CARMEUSE LIME	LEEDS PLANT LONGVIEW LIME PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry and Wet
	N	32	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHEMICAL LIME CO	LEEDS PLANT O'NEAL LIME PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry
	N	34	CEMENT LIME	LEHIGH PORTLAND CEMENT CO SOUTHERN LIME CO	LEEDS PLANT ROBERTA LIME PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry
	N	34	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHEMICAL LIME CO	LEEDS PLANT MONTEVALLO PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry and Wet
		38	CEMENT LIME	LAFARGE NORTH AMERICA INC SPECIALTY MINERALS INC	RAVENA PLANT ADAMS LIME PLANT	NEW YORK MASSACHUSETTS	ALBANY BERKSHIRE	Wet	Wet
		42	CEMENT LIME	ESSROC MATERIALS INC CARMEUSE LIME	FREDERICK PLANT HANOVER LIME PLANT	MARYLAND PENNSYLVANIA	FREDERICK ADAMS	Wet	Wet
		42	CEMENT LIME	ROANOKE CEMENT CO CHEMICAL LIME CO	ROANOKE PLANT LIME PLANT #1	VIRGINIA VIRGINIA	BOTETOURT GILES	Dry	Dry
	44	CEMENT LIME	TXI CORP AUSTIN WHITE LIME CO	HUNTER PLANT MCNEIL LIME PLANT	TEXAS TEXAS	COMAL TRAVIS	Dry	Dry and Wet	
	48	CEMENT LIME	ST LAWRENCE CEMENT SPECIALTY MINERALS INC	CATSKILL PLANT ADAMS LIME PLANT	NEW YORK MASSACHUSETTS	GREENE BERKSHIRE	Wet	Wet	
	49	CEMENT LIME	ESSROC MATERIALS INC GLOBAL STONE CHEMSTONE INC	FREDERICK PLANT STRASBURG LIME PLANT	MARYLAND VIRGINIA	FREDERICK SHENANDOAH	Wet	Dry and Wet	

TABLE 2
CEMENT AND LIME PLANT PAIRS SORTED BY DISTANCE

Map Code	Linear Distance (miles)	Commodity	Company	Site	State	County	Cement Kiln Type*	Lime Kiln Dust Control Type*
N	0	CEMENT LIME	LAFARGE NORTH AMERICA INC SOUTHERN LIME CO	ROBERTA PLANT ROBERTA LIME PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry
I	2	CEMENT LIME	ST MARY'S CEMENT CARMEUSE LIME	DETROIT PLANT RIVER ROUGE LIME PLANT	MICHIGAN MICHIGAN	WAYNE WAYNE	Dry	Dry
H	2	CEMENT LIME	CEMEX USA CHEMICAL LIME CO	BALCONES PLANT NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	COMAL COMAL	Dry	Dry
N	3	CEMENT LIME	LAFARGE NORTH AMERICA INC CHEMICAL LIME CO	ROBERTA PLANT O'NEAL LIME PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry
D	4	CEMENT LIME	LAFARGE CORPORATION LINWOOD MINING & MINERALS CORP	DAVENPORT PLANT LINWOOD LIME PLANT	IOWA IOWA	SCOTT SCOTT	Dry	Dry
C	4	CEMENT LIME	GCC DACOTAH INC PETE LIEN & SONS INC	RAPID CITY PLANT RAPID CITY LIME PLANT	SOUTH DAKOTA SOUTH DAKOTA	PENNINGTON PENNINGTON	Dry and Wet	Dry
N	5	CEMENT LIME	LAFARGE NORTH AMERICA INC CHEMICAL LIME CO	ROBERTA PLANT MONTEVALLO PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry and Wet
N	8	CEMENT LIME	LAFARGE NORTH AMERICA INC CARMEUSE LIME	ROBERTA PLANT LONGVIEW LIME PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry and Wet
N	9	CEMENT LIME	LAFARGE NORTH AMERICA INC CHENEY LIME & CEMENT CO	ROBERTA PLANT LANDMARK LIME PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Dry
L	10	CEMENT LIME	RIVERTON CORP (ESSROC CEMENT CORP) GLOBAL STONE CHEMSTONE INC	RIVERTON PLANT STRASBURG LIME PLANT	VIRGINIA VIRGINIA	WARREN SHENANDOAH	Dry	Dry and Wet
H	10	CEMENT LIME	TXI CORP CHEMICAL LIME CO	HUNTER PLANT NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	COMAL COMAL	Dry	Dry
N	10	CEMENT LIME	LAFARGE NORTH AMERICA INC CHEMICAL LIME CO	ROBERTA PLANT ALABASTER PLANT	ALABAMA ALABAMA	SHELBY SHELBY	Dry	Wet
H	15	CEMENT LIME	ALAMO CEMENT CO CHEMICAL LIME CO	PLANT 1604 (SAN ANTONIO) NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	BEXAR COMAL	Dry	Dry
L	15	CEMENT LIME	CAPITOL CEMENT CORP (ESSROC CEMENT CORP) GLOBAL STONE CHEMSTONE INC	MARTINSBURG PLANT WINCHESTER LIME PLANT	WEST VIRGINIA VIRGINIA	BERKLEY FREDERICK	Wet (likely to be converted to dry within the next 5 years)	Dry
E	18	CEMENT LIME	BUZZI UNICEM USA INC CHEMICAL LIME CO	SELMA PLANT STE GENEVIEVE PLANT	MISSOURI MISSOURI	JEFFERSON STE GENEVIEVE	Dry	Dry
K	19	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CARMEUSE LIME	YORK WHITE CEMENT PLANT HANOVER LIME PLANT	PENNSYLVANIA PENNSYLVANIA	YORK ADAMS	Wet	Wet
A	19	CEMENT LIME	LAFARGE NORTH AMERICA INC GRAYMONT WESTERN US INC	SEATTLE PLANT TACOMA LIME PLANT	WASHINGTON WASHINGTON	KING PIERCE	Wet	Dry

* Cement kilns use raw materials that are either a mixture of "dry" materials or a slurry of "wet" materials. The lime kiln dust (LKD) control processes used at lime kilns consist mainly of systems using fabric filters, electrostatic precipitators, or scrubbers. Fabric filters (baghouses) and electrostatic precipitators produce "dry" LKD, which would be a suitable raw material in "dry" process cement kilns. Scrubbers produce "wet" LKD, which would be a suitable raw material in "wet" process cement kilns.

TABLE 2 (CONTINUED)
CEMENT AND LIME PLANT PAIRS SORTED BY DISTANCE

Map Code	Linear Distance (miles)	Commodity	Company	Site	State	County	Cement Kiln Type	Lime Kiln Dust Control Type
M	20	CEMENT LIME	CEMEX USA GLOBAL STONE TENN LUTTRELL INC	KNOXVILLE PLANT LUTTRELL LIME PLANT	TENNESSEE TENNESSEE	KNOX UNION	Dry	Dry
A	20	CEMENT LIME	ASH GROVE CEMENT CO GRAYMONT WESTERN US INC	SEATTLE PLANT TACOMA LIME PLANT	WASHINGTON WASHINGTON	KING PIERCE	Dry	Dry
K	21	CEMENT LIME	LEHIGH CEMENT CO CARMEUSE LIME	UNION BRIDGE PLANT HANOVER LIME PLANT	MARYLAND PENNSYLVANIA	CARROLL ADAMS	Dry	Wet
L	22	CEMENT LIME	RIVERTON CORP (ESSROC CEMENT CORP) GLOBAL STONE CHEMSTONE INC	RIVERTON PLANT WINCHESTER LIME PLANT	VIRGINIA VIRGINIA	WARREN FREDERICK	Dry	Dry
G	22	CEMENT LIME	TEXAS - LEHIGH CEMENT CO AUSTIN WHITE LIME CO	BUDA PLANT MCNEIL LIME PLANT	TEXAS TEXAS	HAYS TRAVIS	Dry	Dry and Wet
J	22	CEMENT LIME	CEMEX USA MERCER LIME & STONE CO	WAMPUM PLANT BRANCHTON LIME PLANT	PENNSYLVANIA PENNSYLVANIA	LAWRENCE BUTLER	Dry	Wet
F	23	CEMENT LIME	TXI CORP US LIME & MINERALS - TEXAS LIME CO	MIDLOTHIAN PLANT CLEBURNE LIME PLANT	TEXAS TEXAS	ELLIS JOHNSON	Dry and Wet	Dry and Wet
H	24	CEMENT LIME	CAPITOL AGGREGATES LTD CHEMICAL LIME CO	CAPITOL CEMENT (SAN ANTONIO) PLANT NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	BEXAR COMAL	Dry and Wet	Dry
∞	25	CEMENT LIME	ASH GROVE CEMENT CO GRAYMONT WESTERN US INC	MONTANA CITY PLANT INDIAN CREEK LIME PLANT	MONTANA MONTANA	JEFFERSON BROADWATER	Wet	Dry
N	26	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHEMICAL LIME CO	LEEDS PLANT ALABASTER PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Wet
F	26	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHEMICAL LIME CO	WACO PLANT CLIFTON LIME PLANT	TEXAS TEXAS	MCLENNAN BOSQUE	Wet	Wet
E	26	CEMENT LIME	BUZZI UNICEM USA INC MISSISSIPPI LIME CO	SELMA PLANT STE GENEVIEVE LIME PLANT	MISSOURI MISSOURI	JEFFERSON STE GENEVIEVE	Dry	Dry and Wet
F	26	CEMENT LIME	ASH GROVE TEXAS CEMENT US LIME & MINERALS - TEXAS LIME CO	MIDLOTHIAN PLANT CLEBURNE LIME PLANT	TEXAS TEXAS	ELLIS JOHNSON	Wet	Dry and Wet
J	27	CEMENT LIME	ARMSTRONG CEMENT & SUPPLY CORP MERCER LIME & STONE CO	CABOT PLANT BRANCHTON LIME PLANT	PENNSYLVANIA PENNSYLVANIA	BUTLER BUTLER	Wet	Wet
N	27	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHENEY LIME & CEMENT CO	LEEDS PLANT LANDMARK LIME PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry
N	27	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CARMEUSE LIME	LEEDS PLANT LONGVIEW LIME PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry and Wet
K	27	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CARMEUSE LIME	YORK WHITE CEMENT PLANT MILLARD LIME PLANT	PENNSYLVANIA PENNSYLVANIA	YORK LEBANON	Wet	Dry
F	27	CEMENT LIME	HOLCIM (US) INC US LIME & MINERALS - TEXAS LIME CO	MIDLOTHIAN PLANT CLEBURNE LIME PLANT	TEXAS TEXAS	ELLIS JOHNSON	Dry	Dry and Wet

TABLE 2 (CONTINUED)
CEMENT AND LIME PLANT PAIRS SORTED BY DISTANCE

Map Code	Linear Distance (miles)	Commodity	Company	Site	State	County	Cement Kiln Type	Lime Kiln Dust Control Type
J	28	CEMENT LIME	ESSROC MATERIALS INC MERCER LIME & STONE CO	BESSEMER PLANT BRANCTON LIME PLANT	PENNSYLVANIA PENNSYLVANIA	LAWRENCE BUTLER	Wet	Wet
B	29	CEMENT LIME	HOLCIM (US) INC GRAYMONT WESTERN US INC	TRIDENT PLANT INDIAN CREEK LIME PLANT	MONTANA MONTANA	GALLATIN BROADWATER	Wet	Dry
L	31	CEMENT LIME	ESSROC MATERIALS INC GLOBAL STONE CHEMSTONE INC	FREDERICK PLANT WINCHESTER LIME PLANT	MARYLAND VIRGINIA	FREDERICK FREDERICK	Wet	Dry
H	32	CEMENT LIME	TEXAS - LEHIGH CEMENT CO CHEMICAL LIME CO	BUDA PLANT NEW BRAUNFELS LIME PLANT	TEXAS TEXAS	HAYS COMAL	Dry	Dry
N	32	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHEMICAL LIME CO	LEEDS PLANT O'NEAL LIME PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry
K	34	CEMENT LIME	ST LAWRENCE CEMENT CO (HOLCIM, LTD) CARMEUSE LIME	HAGERSTOWN PLANT HANOVER LIME PLANT	MARYLAND PENNSYLVANIA	WASHINGTON ADAMS	Dry	Wet
N	34	CEMENT LIME	LEHIGH PORTLAND CEMENT CO SOUTHERN LIME CO	LEEDS PLANT ROBERTA LIME PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry
N	34	CEMENT LIME	LEHIGH PORTLAND CEMENT CO CHEMICAL LIME CO	LEEDS PLANT MONTEVALLO PLANT	ALABAMA ALABAMA	JEFFERSON SHELBY	Dry	Dry and Wet
G	35	CEMENT LIME	CAPITOL CEMENT CORP (ESSROC CEMENT CORP) GLOBAL STONE CHEMSTONE INC	MARTINSBURG PLANT STRASBURG LIME PLANT	WEST VIRGINIA VIRGINIA	BERKLEY SHENANDOAH	Wet (likely to be converted to dry within the next 5 years)	Dry and Wet
I	36	CEMENT LIME	HOLCIM (US) INC CARMEUSE LIME	DUNDEE PLANT RIVER ROUGE LIME PLANT	MICHIGAN MICHIGAN	MONROE WAYNE	Wet	Dry
L	36	CEMENT LIME	ST LAWRENCE CEMENT CO (HOLCIM, LTD) GLOBAL STONE CHEMSTONE INC	HAGERSTOWN PLANT WINCHESTER LIME PLANT	MARYLAND VIRGINIA	WASHINGTON FREDERICK	Dry	Dry
K	36	CEMENT LIME	LEHIGH CEMENT CO CARMEUSE LIME	EVANSVILLE PLANT MILLARD LIME PLANT	PENNSYLVANIA PENNSYLVANIA	BERKS LEBANON	Dry	Dry
	38	CEMENT LIME	LAFARGE NORTH AMERICA INC SPECIALTY MINERALS INC	RAVENA PLANT ADAMS LIME PLANT	NEW YORK MASSACHUSETTS	ALBANY BERKSHIRE	Wet	Wet
	42	CEMENT LIME	ESSROC MATERIALS INC CARMEUSE LIME	FREDERICK PLANT HANOVER LIME PLANT	MARYLAND PENNSYLVANIA	FREDERICK ADAMS	Wet	Wet
	42	CEMENT LIME	ROANOKE CEMENT CO CHEMICAL LIME CO	ROANOKE PLANT LIME PLANT #1	VIRGINIA VIRGINIA	BOTETOURT GILES	Dry	Dry
	44	CEMENT LIME	TXI CORP AUSTIN WHITE LIME CO	HUNTER PLANT MCNEIL LIME PLANT	TEXAS TEXAS	COMAL TRAVIS	Dry	Dry and Wet
	48	CEMENT LIME	ST LAWRENCE CEMENT SPECIALTY MINERALS INC	CATSKILL PLANT ADAMS LIME PLANT	NEW YORK MASSACHUSETTS	GREENE BERKSHIRE	Wet	Wet
	49	CEMENT LIME	ESSROC MATERIALS INC GLOBAL STONE CHEMSTONE INC	FREDERICK PLANT STRASBURG LIME PLANT	MARYLAND VIRGINIA	FREDERICK SHENANDOAH	Wet	Dry and Wet